

CLAIMS

1 1. A system for producing a flow of liquid or solid xenon in an evacuated
2 chamber, the system comprising means for pressuring and cooling a gaseous flow
3 of xenon to a pressure and a temperature so that upon entering the evacuated
4 chamber, the gaseous xenon liquefies or solidifies within the chamber.

1 2. The system as claimed in claim 1, comprising pump means for drawing the
2 flow of gaseous xenon from the chamber to the pressurising and cooling means,
3 and means for returning the pressurised and cooled gaseous xenon to the
4 chamber.

1 3. The system as claimed in claim 2 wherein the pump means is arranged to
2 create a pressure in the chamber in the range from 1000 mbar to 10^{-10} mbar.

1 4. The system as claimed in claim 2 comprising means for controlling the
2 cooling means such that the temperature of the pressurised gaseous flow returned
3 to the chamber is in the range from ambient temperature to -150°C .

1 5. The system as claimed in claim 2, wherein the pressurising means is
2 arranged to pressurise the gaseous flow to a pressure within the range from 1 to
3 100 bar.

1 6. The system as claimed in claim 2, wherein the cooling means comprises a
2 housing extending about a duct having an inlet for receiving the pressurised
3 gaseous flow and an outlet for returning the flow to the chamber, the housing
4 containing at least one coolant for cooling the flow.

1 7. The system as claimed in claim 2, wherein the housing contains a first
2 coolant in thermal contact with the duct and means extending about the duct for

3 conveying a flow of second coolant within the housing for controlling the
4 temperature of the first coolant.

1 8. The system as claimed in claim 7, wherein the housing comprises a first
2 section and a second section, smaller than the first section, proximate the outlet,
3 the first section containing the means for conveying the second coolant within the
4 housing.

1 9. The system as claimed in claim 8, wherein the first section has a greater
2 external diameter than the second section.

1 10. The system as claimed in claim 7, wherein the conveying means comprises
2 a second duct extending about the first-mentioned duct.

1 11. The system as claimed in claim 10, wherein the second duct comprises a
2 helical duct having an inlet proximate the inlet to the first duct and an outlet
3 proximate the second section of the housing.

1 12. The system as claimed in claim 8, wherein the second section of the
2 housing has a length in the direction of fluid flow through the duct in the range from
3 0.25m to 1.5m.

1 13. The system as claimed in claim 6, wherein the first coolant comprises a
2 halocarbon.

1 14. The system as claimed in claim 13 wherein said halocarbon comprises
2 tetrafluoromethane.

1 15. The system as claimed in claim 7, wherein the second coolant comprises a
2 liquid coolant.

1 16. The system as claimed in claim 16, wherein said liquid coolant comprises
2 liquid nitrogen.

1 17. The system as claimed in claim 7, comprising means for controlling the rate
2 of flow of said second coolant within said conveying means.

1 18. The system as claimed in claim 6, wherein the outlet has means for
2 attaching a nozzle thereto.

1 19. A system for producing a flow of liquid or solid xenon in an evacuated
2 chamber, the system comprising pump means for drawing a flow of gaseous
3 xenon from the chamber, means for pressurising the gaseous flow, and means for
4 cooling the pressurised gaseous flow for return to the chamber, whereby the
5 gaseous xenon returned to the chamber is caused to liquefy or solidify within the
6 chamber.

1 20. The system as claimed in claim 19 wherein the pump means is arranged to
2 create a pressure in the chamber in the range from 1000 mbar to 10^{-10} mbar.

1 21. The system as claimed in claim 19, comprising means for controlling the
2 cooling means such that the temperature of the pressurised gaseous flow returned
3 to the chamber is in the range from ambient temperature to -150°C .

1 22. The system as claimed in claim 19, wherein the pressurising means is
2 arranged to pressurise the gaseous flow to a pressure within the range from 1 to
3 100 bar.

1 23. The system as claimed in claim 19, wherein the cooling means comprises a
2 housing extending about a duct having an inlet for receiving the pressurised
3 gaseous flow and an outlet for returning the flow to the chamber, the housing
4 containing at least one coolant for cooling the flow.

1 24. The system as claimed in claim 19, wherein the housing contains a first
2 coolant in thermal contact with the duct and means extending about the duct for
3 conveying a flow of second coolant within the housing for controlling the
4 temperature of the first coolant.

1 25. The system as claimed in claim 24, wherein the housing comprises a first
2 section and a second section, smaller than the first section, proximate the outlet,
3 the first section containing the means for conveying the second coolant within the
4 housing.

1 26. The system as claimed in claim 25, wherein the first section has a greater
2 external diameter than the second section.

1 27. The system as claimed in claim 26, wherein the conveying means
2 comprises a second duct extending about the first-mentioned duct.

1 28. The system as claimed in claim 27, wherein the second duct comprises a
2 helical duct having an inlet proximate the inlet to the first duct and an outlet
3 proximate the second section of the housing.

1 29. The system as claimed in claim 28, wherein the second section of the
2 housing has a length in the direction of fluid flow through the duct in the range from
3 0.25m to 1.5m.

1 30. The system as claimed in claim 25, wherein the first coolant comprises a
2 halocarbon.

1 31. The system as claimed in claim 30 wherein said halocarbon comprises
2 tetrafluoromethane.

1 32. The system as claimed in claim 25, wherein the second coolant comprises
2 a liquid coolant.

1 33. The system as claimed in claim 32 wherein said liquid coolant comprises
2 liquid nitrogen.

1 34. The system as claimed in claim 32, comprising means for controlling the
2 rate of flow of said second coolant within said conveying means.

1 35. The system as claimed in claim 28, wherein the outlet has means for
2 attaching a nozzle thereto.

1 36. An apparatus for cooling a flow of fluid, comprising a duct having an inlet for
2 receiving the fluid flow and an outlet, and a housing extending about the duct, the
3 housing containing a first coolant in thermal contact with the duct for cooling the
4 fluid flow, the housing comprising a first section and a second section, smaller than
5 the first section, proximate the outlet, the first section containing means in thermal
6 contact with the first coolant for conveying within the housing a flow of a second
7 coolant for controlling the temperature of the first coolant.

1 37. The apparatus as claimed in claim 36, wherein the first section has a
2 greater external diameter than the second section.

1 38. The apparatus as claimed in claim 36, wherein the conveying means
2 comprises a second duct extending about the first-mentioned duct.

1 39. The apparatus as claimed in claim 38, wherein the second duct comprises a
2 helical duct having an inlet proximate the inlet to the first duct and an outlet
3 proximate the second section of the housing.

1 40. The apparatus as claimed in claim 38, wherein the second section of the
2 housing has a length in the direction of fluid flow through the duct in the range from
3 0.25m to 1.5m.

1 41. The apparatus as claimed in claim 36, wherein the first coolant comprises a
2 halocarbon.

1 42. The apparatus as claimed in claim 41 wherein said halocarbon comprises
2 tetrafluoromethane.

1 43. The apparatus as claimed in claim 36, wherein the second coolant
2 comprises a liquid coolant.

1 44. The apparatus as claimed in claim 43 wherein said liquid coolant comprises
2 liquid nitrogen.

1 45. The apparatus as claimed in claim 36, comprising means for controlling the
2 rate of flow of said second coolant within said conveying means.

1 46. The apparatus as claimed in claim 36, wherein the outlet has means for
2 attaching a nozzle thereto.

1 47. A method of producing a flow of liquid or solid xenon in an evacuated
2 chamber using the system as claimed in claim 1.

1 48. A method of cooling a flow of fluid utilizing the apparatus as claimed in
2 claim 36.

1 49. A method of producing a flow of liquid or solid xenon using the apparatus as
2 claimed in claim 36.

- 1 50. A method of producing a flow of liquid or solid xenon in an evacuated
- 2 chamber using the system as claimed in claim 19.